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PENSOFT

Non-volant mammals of the Serra da Fortaleza Wildlife Refuge, southern Goiás, central Brazil

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Abstract. Protected areas are essential for the maintenance of biodiversity, but we know little about local biodiversity in these areas. In this study, we describe the composition and structure of the non-volant mammal community in the Serra da Fortaleza Wildlife Refuge in southern Goiás state, central Brazil. We distributed 20 hexagons (~57 ha each), 10 in the protected area and 10 in its surroundings. We collected data on composition, richness, and abundance of non-volant mammals using live and pitfall traps, camera traps, and active searching. We recorded 39 species (five threatened) of non-volant mammals. The use of diverse sampling methods allowed for a comprehensive depiction of mammal diversity and composition, lead to the discovery of new species records for the region, including *Marmosa limae* Thomas, 1920, *Cerradomys scotti* (Langguth & Bonvicino, 2002), *Hylaeamys megacephalus* (G. Fischer, 1814), and *Tayassu pecari* (Link, 1795). We emphasize the importance of protected areas for the conservation of the mammal fauna in the highly fragmented landscape of central Brazil.

Keywords. Biodiversity, camera trap, conservation, protected area, sampling methods.

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Introduction

The main anthropic drivers of decline in biodiversity have been identified as habitat loss and fragmentation (Fahrig 2003; Haddad et al. 2015), and thus it is important to identify biodiversity hotspots concentrating numerous endemic species under exceptional risk of habitat loss (Myers et al. 2000; Mittermeier et al. 2004). In Brazil, the Atlantic Forest and the Cerrado are the key threatened biomes, and they contain 76% of the Brazilian protected areas (MMA 2021). Despite this, there is still limited knowledge of the biodiversity inside Brazilian protected areas. Approximately 50% of these areas have never been surveyed, and there are no records species occurring in them (Oliveira et al. 2017). Therefore, new inventories are crucially needed to comprehensively map biodiversity in protected areas in Brazil, especially in the context of managing fragmented landscapes. By addressing such challenges, we can effectively foster biodiversity preservation, ensuring the continued provision of essential ecosystem services.

Studies on the impacts of habitat loss and frag-

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mentation have often focused on mammal diversity (Andrén 1994; Melo et al. 2017; Regolin et al. 2021) and have highlighted the importance of protected areas for mammal conservation (Newmark 1987; Ferreira et al. 2020). Brazil harbors 775 species of mammals, mainly rodents, bats, and primates, with each of these mammal groups having about of a hundred species (Abreu et al. 2022). Non-volant mammals account for 76.5% of the Brazilian mammalian diversity; they are commonly classified as either small (i.e. <1 kg, mostly marsupials [order Didelphimorphia], cottontail rabbits [order Lagomorpha], and small rodents [order Rodentia]) or medium-sized and large (i.e. >1 kg, all other orders) (Emmons and Feer 1997). Such pronounced diversity in species and phenotypes is the result of long historical and ecological processes (Safi et al. 2011) and have yielded rich habits, behaviors, and life histories.

A range of sampling and capture methods are necessary to broadly access the diversity of Brazilian mammals (Voss and Emmons 1996). For instance, live traps and pitfall traps have been widely employed in capturing non-volant small mammals (Bovendorp et al. 2017), while camera traps are satisfactorily used in surveying medium-sized to large mammals. Camera traps require low investment in training and fieldwork hours, and the captured photos suffice for the accurate identification of most species (Srbek-Araujo and Chiarello 2005). However, we note that many studies assessing the various sampling methods have focused primarily on the mammal fauna of non-protected areas (Oliveira et al. 2017) from southeastern Brazil (Brito et al. 2009).

Goiás is one of the eight states of Brazil for which there is a checklist of the native mammalian fauna, The state's fauna comprises 191 species, including bats, rodents, carnivorans, and marsupials that have been recorded exclusively in protected areas (Hannibal et al. 2021). Most studies conducted in Goiás have investigated non-volant mammals separated in size classes as either small, medium, or large (Hannibal et al. 2021). For the present study, we investigated the relative importance of the protected area Serra da Fortaleza Wildlife Refuge (SFWR) for the maintenance of non-volant mammalian diversity in the Goiás state, central Brazil. Here, we present lists of the composition, richness, and abundance of non-volant mammals recorded in the SFWR and attempt to answer the following questions:

- Which species are the most abundant, the rarest, and the commonest in the studied landscape?
- Has the mammalian fauna been satisfactorily investigated, considering the recorded community structure?
- What is the relative importance of each sampling method non-volant mammals?

Study Area

The protected area Serra da Fortaleza Wildlife Refuge (SFWR at its center 18.2456°S, 050.6847°W) was established by municipal law no. 3173 on 12 August 2015. It is located at Quirinópolis in the southern mesoregion of Goiás (Fig. 1). The protected area is approximately 490 ha and contains a mosaic of ecosystems, including gallery forests, semideciduous forests, and shrubland formations, which are surrounded by a fragmented landscape of corn, sugar cane, and pasture plantations. Regardless of the fragmentation of the landscape, it is an important area for biodiversity conservation in southern Goiás and for the Cerrado (Ribeiro and Walter 2008; IBGE 2011; Morais et al. 2021). The local climate is classified as "Aw" according to the Köppen system, with two well-defined seasons: rainy from October to March and dry from April to September (Alvarez et al. 2013).

In the fragmented landscape where the SFWR is inserted, we plotted 20 hexagons (henceforth referred to as "sampling units") measuring approximately 57 ha each. Ten hexagons were placed in the protected area and 10 in the surrounding area (Fig. 1). We delimitated the hexagons on the landscape using an input layer of a raster file of the studied region available from the MapBiomas database (MapBiomas 2022), later employing QGIS v. 3.22.4 software (QGIS 2018) to subdivide the landscape into six main classes by land use and vegetation type: forest formation, shrubland formation, sylviculture, pasture plantation, agriculture and grassland formation. The location of the protected area in Brazil and Goiás and the 20 sampling units within it are shown in Figure 1.

Methods

Sampling design. Sampling efforts took place from 2020 to 2022 every three months, totaling 12 sampling surveys during both the dry and rainy seasons. In each year that we surveyed, we sampled five hexagons (e.g. 2020: survey 1 [H1–5], survey 2 [H6–10], survey 3 [H11–15], survey 4 [H16–20]) for 10 days, totaling 20 hexagons by the end of the 12 months. To increase the chances of capture, the same hexagons sampled during the rainy season in one year were resampled during the dry season of the following year, and vice versa, so that each hexagon was sampled at least once during each season. We set up the capture stations as close as possible to the center of each hexagon, creating a minimum distance of 700 m between capture stations up to the maximum distance of 7,600 m.

Mammal surveys. We captured the small non-volant mammals (rodents and marsupials) using 20 live traps (10 wire cage traps and 10 Sherman traps) per hexagon. The traps were arranged along two 60 m long transects, with five capture stations per transect, spaced 15 m apart. Each capture station had two traps (one wire cage and one Sherman) alternately set on the ground and 1.5–2 m high in the understory (Fig. 2). The traps were left open for five nights in 2020 and seven nights in 2021 and 2022 and totaled 380 trap-nights per hexagon. Additionally, in 2021 and 2022, pitfall traps were

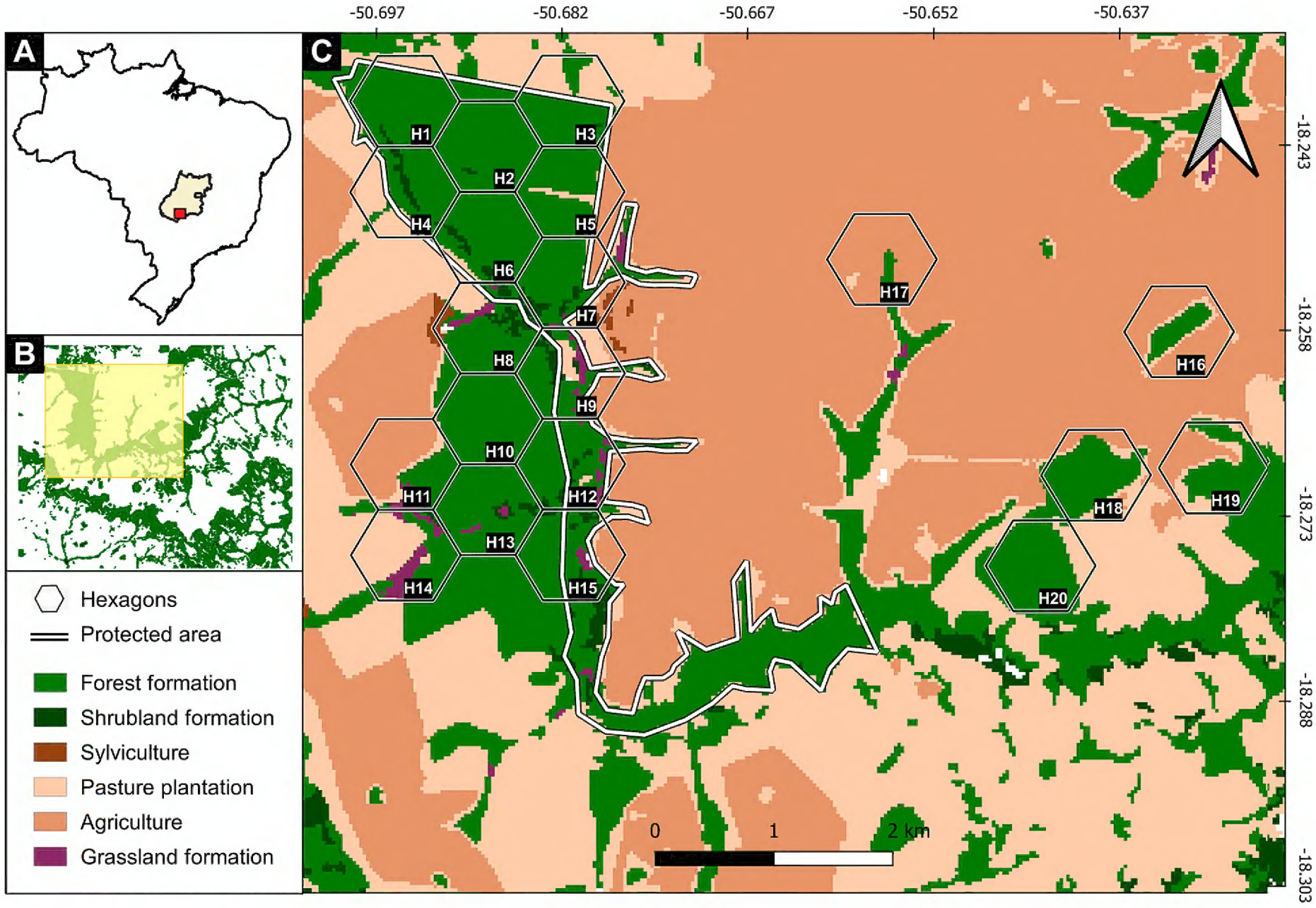

Figure 1. A. Map of Brazil, showing Goiás state and location of the Serra da Fortaleza Wildlife Refuge (dot). **B.** The fragmented landscape in southern Goiás, showing native (green) and non-native (white) vegetation cover (with **C** highlighted. **C.** Serra da Fortaleza Wildlife Refuge (extent marked by a double line) and sampling units (hexagons).

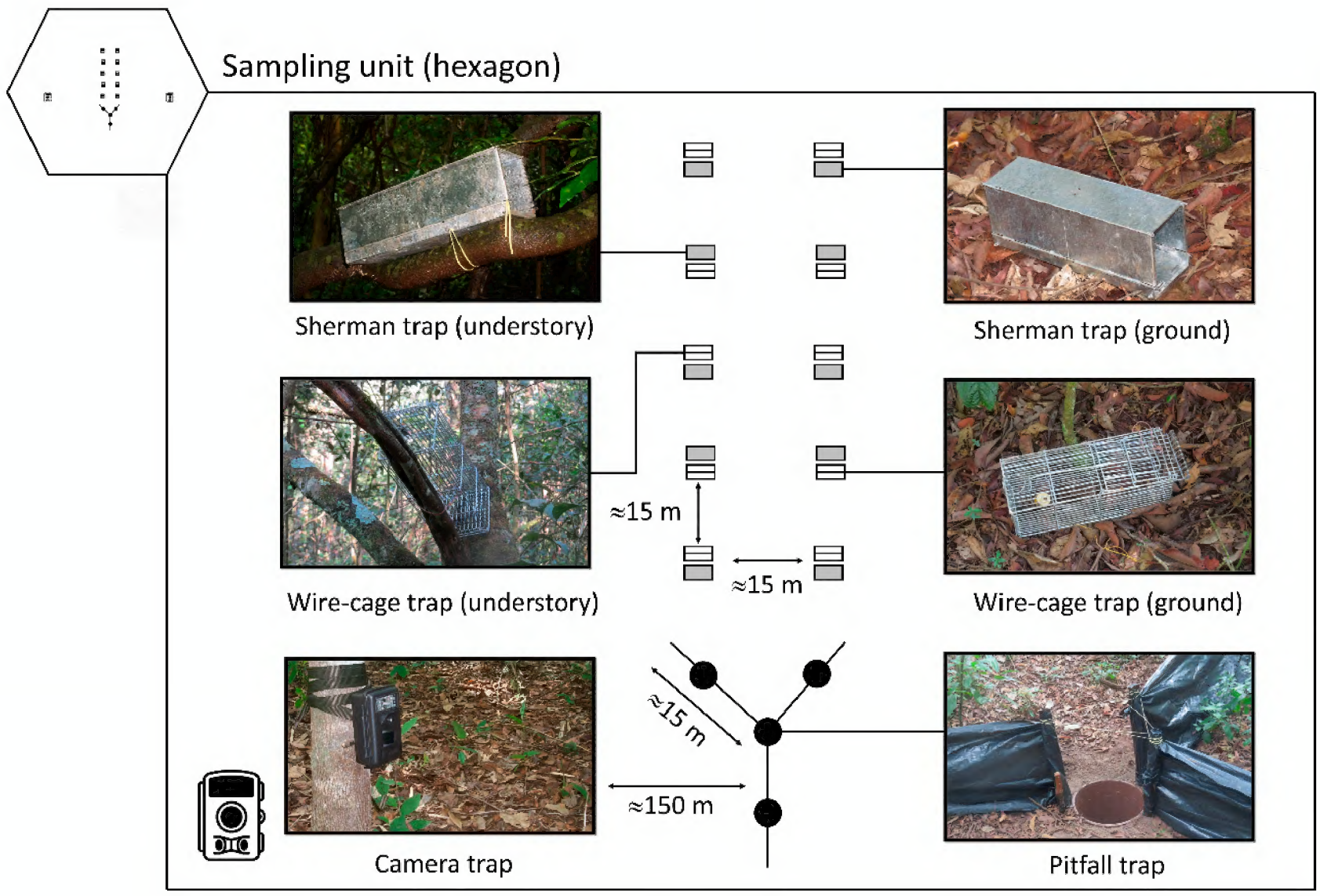

Figure 2. Methods for capturing and monitoring non-volant mammals in the protected area Serra da Fortaleza Wildlife Refuge, southern Goiás, central Brazil.

added to each hexagon, consisting of four 60 L buckets arranged in a Y-shape and interconnected by an 80 cm high fence (Fig. 2). The pitfall traps were left open for seven nights, totaling an effort of 56 bucket-nights per hexagon. Small mammals were captured and tagged with ear tags (ZT 900 no. 1, ~7 mm) and released at the site of capture. Some specimens of each species or each morphospecies were collected and deposited in the mammal collection of the Goiás State University (CM-UEG).

Active searches were conducted for 90 min in each hexagon to record i) direct observations, ii) footprints, iii) burrows (in the case of armadillos), iv) feces, and v) road kills (medium-sized and large mammals). In 2021 and 2022, we used two camera traps in each hexagon spaced 300 m apart for 10 consecutive days, totaling 20 camera-days per hexagon (Fig. 2). We used camera traps (Bushnell 1119932C) set for uninterrupted operation (day and night), capturing three photos every 10 seconds and 5-second videos when triggered to record, recording date and time. The camera traps were positioned on tree trunks at an approximate height of 40 cm above the ground. The chances of successful capture-recording is often increased by using bait with camera traps (Tomas and Miranda 2003), and our camera traps were baited with mortadella, corn, banana, and salt with the intention of attracting a greater diversity of species.

The taxonomic nomenclature followed Abreu-Jr et al. (2022), except in *Marmosa* (*Micoureus*) *limae* that we follow Voss et al. (2020). Tracks and other evidence were identified according to Borges and Tomas (2004) and Hannibal et al. (2015a). Specimens were identified using external morphological characteristics due to current restriction on accessing to cranial morphology, cytogenetic, and molecular data. Didelphid marsupials were identified according to Gardner (2008), Voss and Jansa (2009), Voss et al. (2020), and Antunes et al. (2021a), and small rodents were consulted according to Bonvicino et al. (2008), Patton et al. (2015), Antunes et al. (2021b); Suárez-Villota et al. (2018) (see the "Identification section" of each species found). The species were classified as threatened following the Official List of Brazilian Fauna Threatened with Extinction (MMA 2022) and/or the Red List of Threatened Species of the International Union for Conservation of Nature (IUCN 2022). The capture and collection of specimens were authorized by the Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio no. 69328-1, 69328-2, 79453-1) and the Ethics Committee on the Use of Animals of the State University of Goiás (CEUA-UEG no. 009/2019). The manipulation and tagging of the mammals are in accordance with the American Society of Mammalogists guide (Sikes and Gannon 2011).

Data analysis. We describe the composition and structure of the non-volant mammal community of the SFWR and its surroundings in terms of its richness (number of species) and abundance (number of individuals or frequency of records). For small-mammal abundance, we considered the first capture of each specimen (Fernandez 1995), while for medium-sized and large mammals, we considered the frequency of photographic records with a 1 h break between each record/species (Gómez et al. 2005). Mammals recorded by tracks and other evidence were counted only once in each hexagon/survey. So, we describe the most frequent and rarest species in the landscape of the protected area using the frequency of occurrence (FO%) by the equation $FO\%i = NRi / Records \times 100$, where the percentage frequency of occurrence of species *i* (FO%*i*) is equal to the number of records of species *i* (NR*i*) divided by the total records of all species (Records), multiplied by 100 (Hannibal and Godoi 2015). We considered as common those species recorded in >50% of the hexagons; for this approach we used the equation $FH\%i = Nhi / 20 \times 100$, where the percentage frequency of species *i* in the hexagons is equal to the number of hexagons in which species was recorded, divided by 20 (total hexagons) and multiplied by 100 (MacKenzie et al. 2017).

We used the rarefaction accumulation curve and the Jackknife 1 richness estimator to investigate if the community had been satisfactorily sampled. In such case, a decrease in the average number of new species (by rarefaction) would be associated with increased sampling efforts (represented by surveys every three months). We described the percentage of species observed relative to the total number of species estimated for the study area. In addition, we plotted species diversity in the study area based on Hill numbers (e.g. $q = 0$: species richness, $q = 1$: Shannon's entropy, $q = 2$: Simpson's dominance) (Hill 1973; Roswell et al. 2021). The rarefaction accumulation curve and the Jackknife 1 estimator were run using the EstimatesWin910 Program (Colwell 2022). The Hill numbers was calculated using the 'iNEXT' package (Hsieh and Chao 2020) in the R environment v. 4.1.3 (R Core Team 2022).

To investigate the role of different methods in sampling and the capture of different orders of non-volant mammals, we considered the first record of each species of the order associated with the respective sampling method (e.g. first capture of *Didelphis albiventris* Lund, 1840 in live trap + first record of *D. albiventris* in camera trap = 2-Didelphimorphia + 1-live trap and 1-camera trap). With the presence matrix (order-method) we constructed the interaction networks by using the 'bipartite' package (Dormann et al. 2009) in R (R Core Team 2022).

Results

We recorded 39 species of non-volant mammals from the orders Rodentia (12 spp.), Carnivora (7 spp.), Didelphimorphia (6 spp.), Cetartiodactyla (4 spp.), Cingulata (4 spp.), Pilosa (2 spp.), Primates (2 spp.), Lagomorpha (1 sp.), and Perissodactyla (1 sp.) (Table 1, Fig. 3). Giant Armadillo *Priodontes maximus* (Kerr, 1792), Giant Anteater *Myrmecophaga tridactyla* Linnaeus, 1758, Maned Wolf *Chrysocyon brachyurus* (Illiger, 1815),

Table 1. Checklist of non-volant mammals of the Serra da Fortaleza Wildlife Refuge, in central Brazil. Abbreviations: $FO_{(\%)}$ = frequency of occurrence; $FH_{(\%)}$ = frequency on hexagons; * = vulnerable species according Brazilian Red List (MMA 2022); IUCN (International Union for Conservation Natures Red List) categories: LC = Least Concern, NT = Near Threatened, DD = Data Deficient, VU = Vulnerable; Record type: B = burrow, Ct = camera trap, Do = direct observation, F = feces, Lt = live trap, Pt = pitfall trap, Rk = roadkill, T = tracks.

Taxon	$FO_{(\%)}$	$FH_{(\%)}$	IUCN	Record
DIDELPHIMORPHIA Gill, 1872				
Didelphidae Gray, 1821				
Caluromys philander (Linnaeus, 1758)	0.40	15	LC	Lt
Didelphis albiventris Lund, 1840	8.87	75	LC	Lt, Ct
Gracilinanus agilis (Burmeister, 1854)	12.98	70	LC	Lt, Pt
Marmosa limae Thomas, 1920	0.13	5	LC	Lt
Marmosa murina (Linnaeus, 1758)	0.79	25	LC	Lt
Monodelphis kunsi Pine, 1975	0.26	10	LC	Pt
CINGULATA Illiger, 1811				
Chlamyphoridae Bonaparte, 1850				
Cabassous squamicaudis (Lund, 1845)	0.26	5	LC	B, Do
Euphractus sexcinctus (Linnaeus, 1758)	0.66	10	LC	Ct, Do, T
Priodontes maximus (Kerr, 1792) *	0.79	20	VU	B, Ct, Do, T
Dasypodidae Gray, 1821				
Dasypus novemcinctus Linnaeus, 1758	2.91	60	LC	Ct, Do, Rk, T
PILOSA Flower, 1883				
Myrmecophagidae Gray, 1825				
Myrmecophaga tridactyla Linnaeus, 1758 *	1.32	40	VU	Ct, Do, T
Tamandua tetradactyla (Linnaeus, 1758)	0.26	10	LC	Ct, Do
PRIMATES Linnaeus, 1758				
Cebidae Gray, 1830				
Callithrix penicillata (É. Geoffroy, 1812)	0.13	5	LC	Do
Sapajus libidinosus (Spix, 1823)	1.46	25	NT	Do, Ct, T
LAGOMORPHA Brandt, 1855				
Leporidae Fischer, 1817				
Sylvilagus minensis Thomas, 1901	0.93	10	LC	Ct
RODENTIA Bowdich, 1821				
Caviidae Fischer, 1817				
Hydrochoerus hydrochaeris (Linnaeus, 1766)	0.26	5	LC	T
Cricetidae Fischer, 1817				
Calomys expulsus (Lund, 1840)	2.78	25	LC	Lt, Pt
Calomys tener (Winge, 1887)	0.53	15	LC	Pt
Cerradomys scotti (Langguth & Bonvicino, 2002)	0.53	10	LC	Lt
Hylaeamys megacephalus (G. Fischer, 1814)	0.40	15	LC	Lt. Pt
Oecomys cleberi Locks, 1981	3.31	65	LC	Lt
Oecomys catherinae Thomas, 1909	0.13	5	LC	Lt
Oligoryzomys mattogrossae (J.A. Allen, 1916)	1.19	35	LC	Lt, Pt
Rhipidomys macrurus (Gervais, 1855)	0.13	5	LC	Lt
Cuniculidae G.S. Miller & Gidley, 1918				
Cuniculus paca (Linnaeus, 1766)	4.40	15	LC	Ct, T
Dasyproctidae Bonaparte, 1838				
Dasyprocta azarae Lichtenstein, 1823	11.66	50	DD	Ct, Do, T
Erethizontidae Bonaparte, 1845				
Coendou longicaudatus boliviensis (Brandt, 1835)	0.13	5	LC	Ct
CARNIVORA Bowdich, 1821				
Canidae Fischer, 1817				
Cerdocyon thous (Linnaeus, 1766)	1.72	20	LC	Ct, Rk, T
Chrysocyon brachyurus (Illiger, 1815) *	0.53	10	NT	Ct, T
Felidae Fischer, 1817				
Puma concolor (Linnaeus, 1771)	0.93	15	LC	Ct, Do, T
Leopardus pardalis (Linnaeus, 1758)	0.40	15	LC	Ct
Mustelidae Fischer, 1817				
Eira barbara (Linnaeus, 1758)	1.32	40	LC	Ct

Taxon	$FO_{(\%)}$	$FH_{(\%)}$	IUCN	Record
Procyonidae Gray, 1825				
Nasua nasua (Linnaeus, 1766)	0.93	25	LC	Ct, Do
Procyon cancrivorus (Cuvier, 1798)	0.26	5	LC	Ct
PERISSODACTYLA Owen, 1848				
Tapiridae Gray, 1821				
Tapirus terrestris (Linnaeus, 1758) *	17.22	85	VU	F, Ct, Do, T
CETARTIODACTYLA Montgelard, Catzeflis & Douzery, 1997				
Cervidae Goldfuss, 1820				
Mazama americana (Erxleben, 1777)	0.66	25	DD	Ct
Subulo gouazoubira (Fischer, 1814)	1.19	30	LC	Ct
Tayassuidae Palmer, 1897				
Dicotyles tajacu (Linnaeus, 1758)	16.69	95	LC	Ct, Do, T
Tayassu pecari (Link, 1795)	0.40	5	VU	Ct

Lowland Tapir *Tapirus terrestris* (Linnaeus, 1758), and White-lipped Peccary *Tayassu pecari* (Link, 1795) are Vulnerable according to Brazilian criteria. In the IUCN Red List, Bearded Capuchin *Sapajus libidinosus* (Spix, 1823) and Maned Wolf are considered Near Threatened, while Azara's Agouti *Dasyprocta azarae* Lichtenstein, 1823 and Red-brocket *Mazama americana* (Erxleben, 1777) are Data Deficient (Table 1).

Of all recorded species, 87% (n = 34) presented a frequency of occurrence below 5%, and 71% of all species (n = 28) occurred in only five hexagons (Table 1). Lowland Tapir *T. terrestris*, Collared Peccary *Dicotyles tajacu* (Linnaeus, 1758), Agile Gracile Opossum *Gracilinanus agilis* (Burmeister, 1854), Azara's Agouti *D. azarae*, and White-eared Opossum *Didelphis albiventris* were the most frequent species (13.48 ± 3.50). Cleber's Oecomys *Oecomys cleberi* Locks, 1981 and Nine-banded Armadillo *Dasypus novemcinctus* Linnaeus, 1758 were the most common species our study across the landscape, occurring in more than 50% of the hexagons (Table 1, Fig. 3).

After two years of sampling, the number of species detected had almost tripled, starting with 13 and reaching 35 species; however, in the last year, on average, less than one species was added to the community in each survey (Fig. 4). This pattern was also observed by the estimated richness curve, with an average of five species more when compared to the observed richness. Thus, the number of species represented 90.7% of the total estimated for the fragmented landscape of the protected area (Fig. 4). An increase in diversity based on the number of individuals (Hill numbers) was also observed. Richness ($q = 0$) showed a tendency to increase in the number of species even after interpolation (750

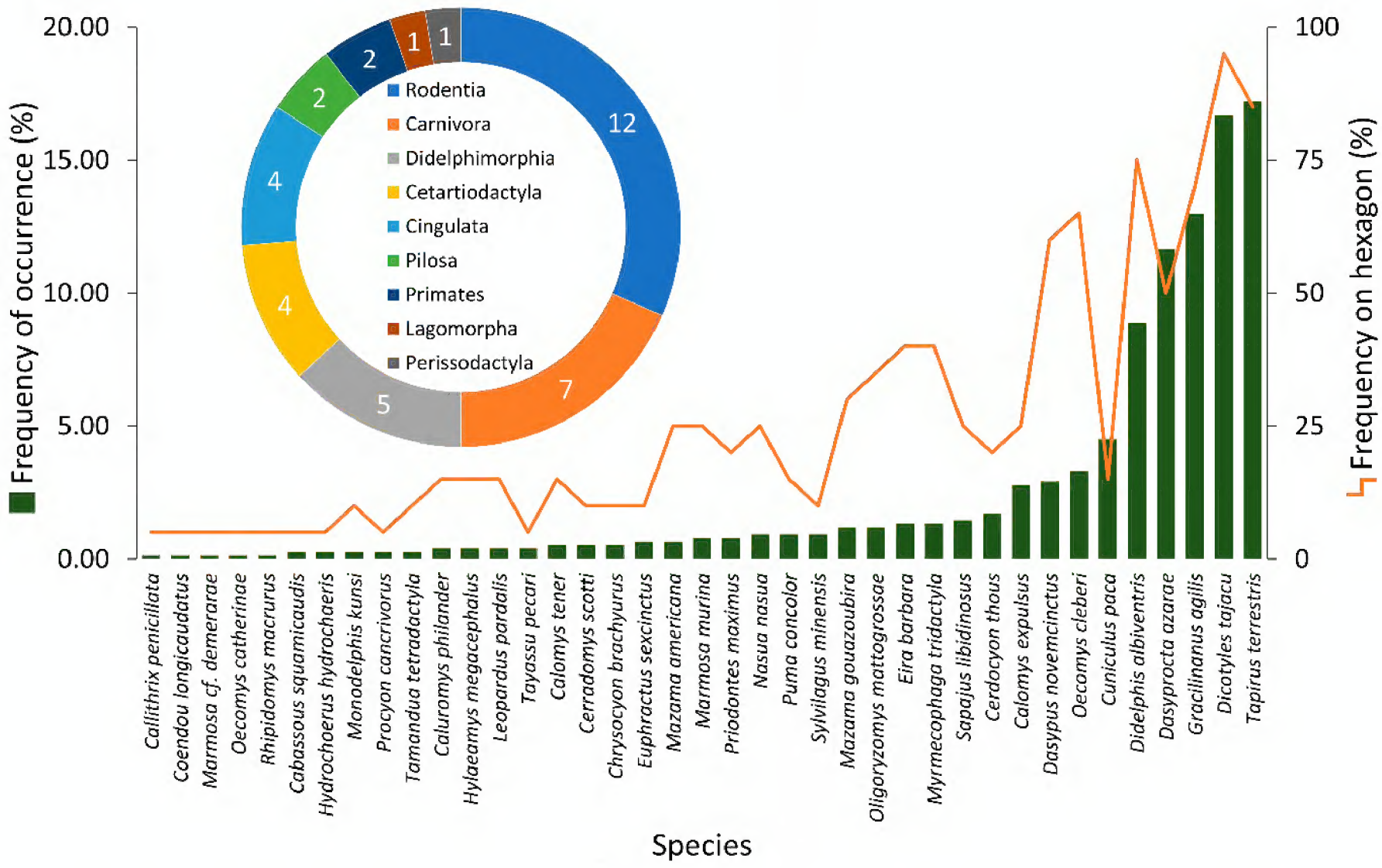

Figure 3. Numbers of species by taxonomic order (pie chart), frequency of occurrence, and frequency of occurrence on hexagon for non-volant mammals in the Serra da Fortaleza Wildlife Refuge, southern Goiás, central Brazil.

individuals), while Shannon diversity ($q = 1$) and Simpson dominance ($q = 2$) stabilized at the first 200 individuals (Fig. 4).

The use of different sampling methods was crucial in recording numerous species from each mammalian order (Table 1). Camera traps contributed records to all orders, especially carnivores (Figs. 5, 6), while live-pitfall traps contributed to records of small mammals (orders Didelphimorphia and Rodentia) (Figs. 5, 7). Direct observation and tracks enabled recording 13 species distributed in seven and six orders, respectively (Table 1, Figs. 5, 7).

Order Didelphimorphia Gill, 1872
Family Didelphidae Gray, 1821
Subfamily Caluromyinae Kirsch, 1977

***Caluromys philander* (Linnaeus, 1758)**
Figure 7G

Materials examined. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18.2739, –050.6838, 785 m; 31.VIII.2020; ACBD obs.; seasonal semi-deciduous forest, wire-cage live trap; ♂.

Identification. The head is grayish and small, with a dark brown longitudinal band between the ears, which extends from the top of the head to the muzzle. The dorsal pelage is soft and thick, brown to light orange-brown, becoming buff or beige on the sides. The ventral pelage varies from orange to grayish (Gardner 2008; Antunes et al. 2021a).

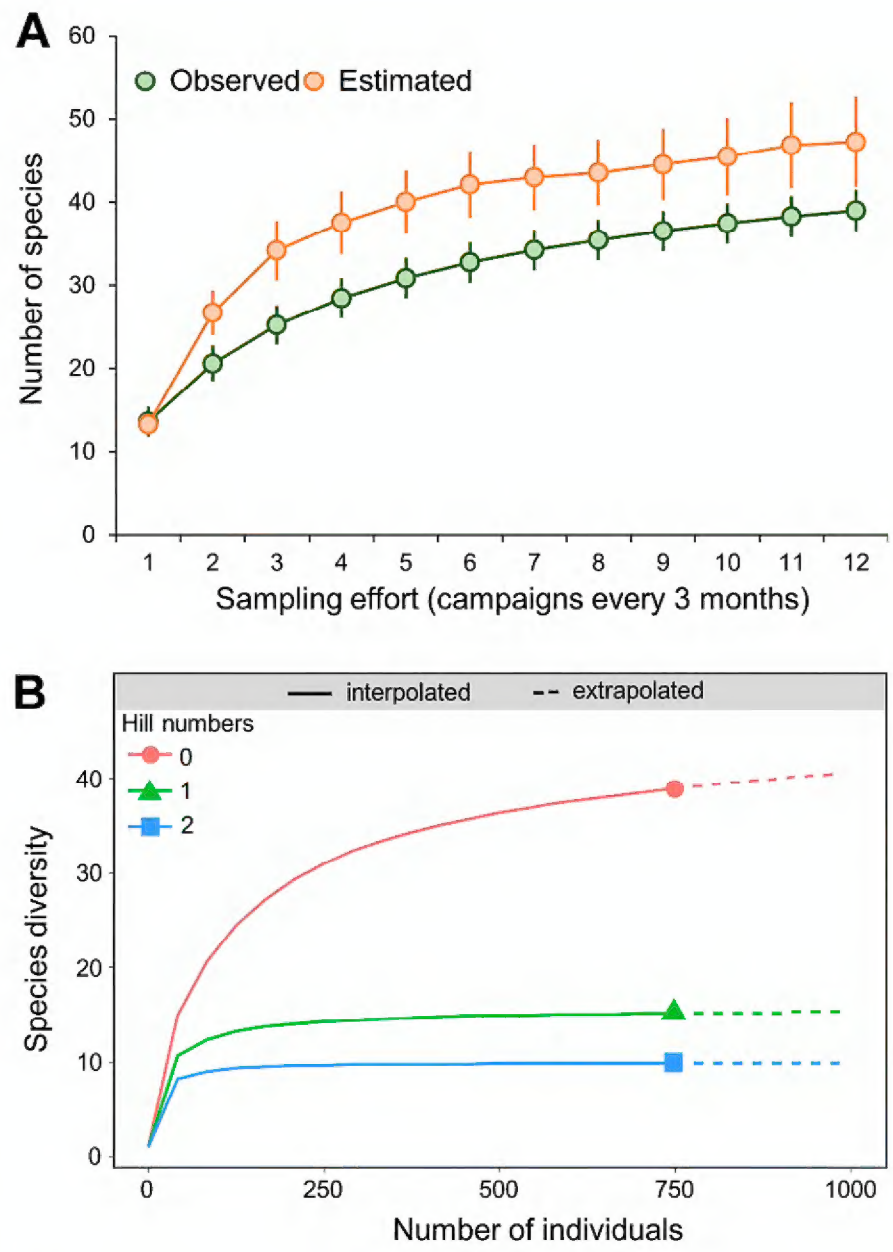

Figure 4. A. Species-accumulation curve for observed and estimated (Jackknife 1). **B.** Species-diversity curve (Hill numbers) for non-volant mammals in the Serra da Fortaleza Wildlife Refuge, southern Goiás, central Brazil.

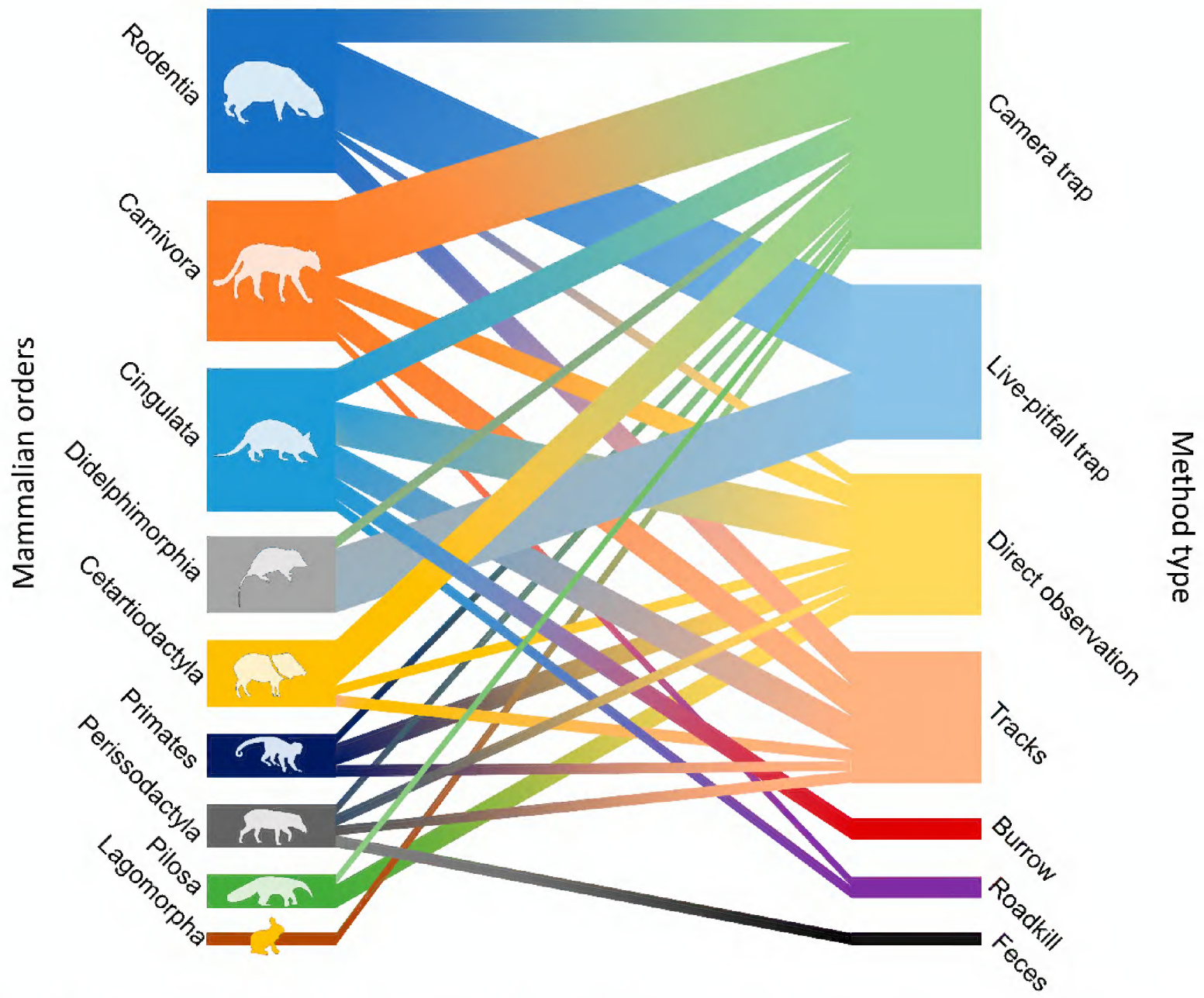

Figure 5. Interaction network between orders of mammals and sampling methods for non-volant mammals from sampling efforts in the Serra da Fortaleza Wildlife Refuge, southern Goiás, central Brazil

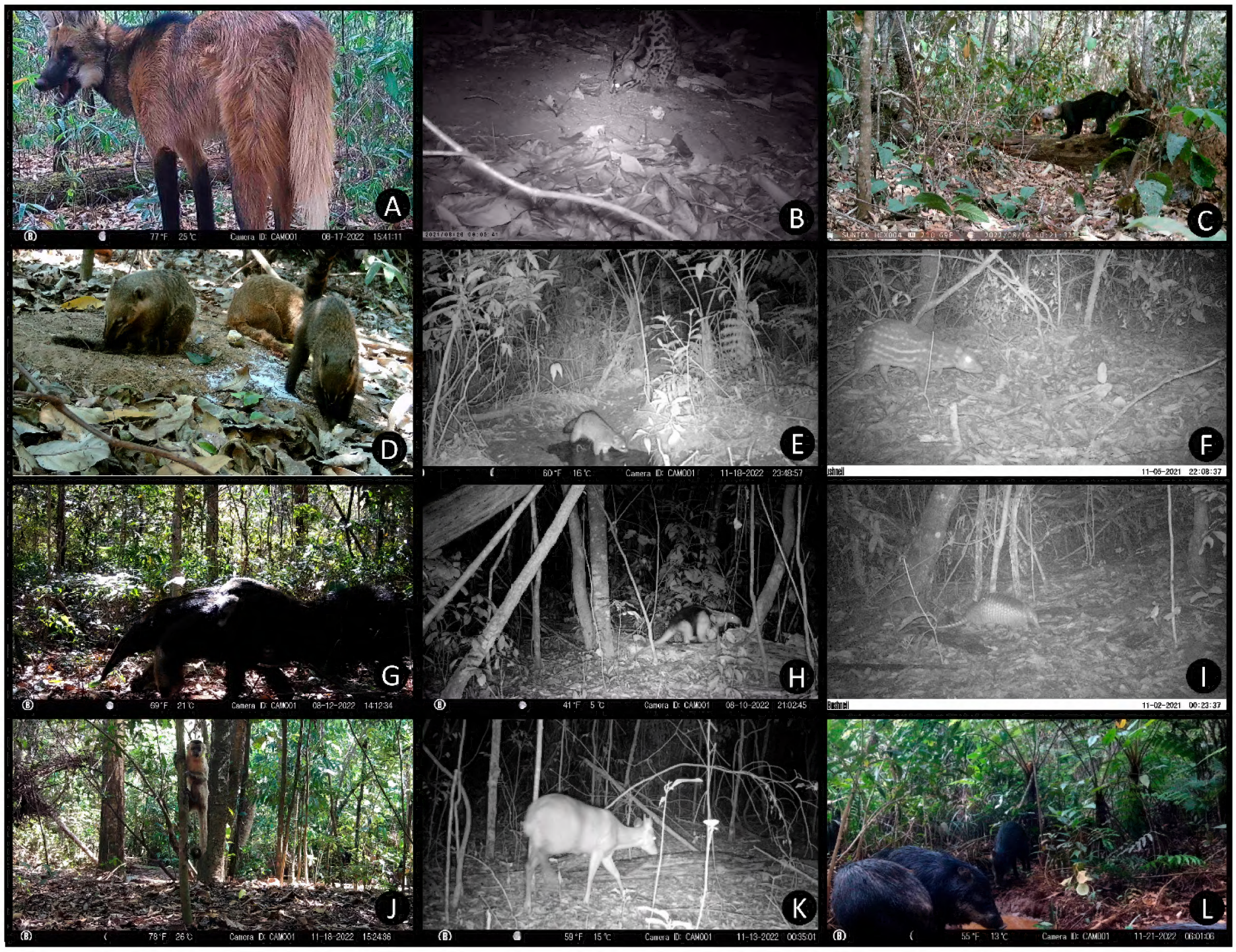

Figure 6. Mammalian species recorded by camera traps in the Serra da Fortaleza Wildlife Refuge, southern Goiás, central Brazil. **A.** *Chrysocyon brachyurus*. **B.** *Leopardus pardalis*. **C.** *Eira barbara*. **D.** *Nasua nasua*. **E.** *Procyon cancrivorus*. **F.** *Cuniculus paca*. **G.** *Myrmecophaga tridactyla*. **H.** *Tamandua tetradactyla*. **I.** *Dasypus novemcinctus*. **J.** *Sapajus libidinosus*. **K.** *Mazama americana*. **L.** *Tayassu pecari*.

Subfamily Didelphinae Gray, 1821
Tribe Didelphini Gray, 1821

***Didelphis albiventris* Lund, 1840**
Figure 7F

Materials examined. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18.2568, –050.6316; 785 m; 08.XI.2020; ACBD obs.; seasonal semi-deciduous forest, wire-cage live trap; ♂.

Identification. The dorsal coat is usually whitish-grey and rarely blackish. The coat on the belly is white, as well as the face, which has three dark stripes, one in the center and two side stripes over the eyes, forming a mask. The tail is prehensile, with hairs in the first few centimeters of the proximal portion (Gardner 2008; Antunes et al. 2021a).

Tribe Thylamyini Hershkovitz, 1992

***Gracilinanus agilis* (Burmeister, 1854)**

Materials examined. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18.2571, –050.6325; 785 m; 07.XI.2020, 25.VIII.2021, 05.XI.2021, 08.XI.2021; ACBD skin and skull.; seasonal semi-deciduous forest, wire-cage live trap; 5♀, 1♂, CMUEG-112, CMUEG-129, CMUEG-130, CMUEG-131, CMUEG-132, CMUEG-134.

Identification. The dorsal pelage is dense, soft, and grayish-brown. The venter consists of hair with a gray base and cream-yellow apex from the anus to the chest, while the region above the chest to the throat is homogeneously cream. The tail is prehensile, slightly bicolored (light on the belly and brown on the back), and covered with tiny visible hairs (Gardner 2008; Antunes et al. 2021a).

Tribe Marmosini Hershkovitz, 1992

***Marmosa* (*Marmosa*) *murina* (Linnaeus, 1758)**

Materials examined. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18.2399, –050.6954; 785 m; 16.VIII.2022; ACBD skin and skull.; seasonal semi-deciduous forest, wire-cage live trap; 1♂, 1♀, CMUEG-148, CMUEG-149.

Identification. This species is similar to *G. agilis* and *M. limae*. *Marmosa murina* has cream-colored ventral fur restricted to the midline and bordered by a lateral band of gray-based hairs, the ear pinna near the auditory canal are yellowish, and the tail is naked. In *G. agilis* the fur is composed entirely of hairs with a gray base and yellowish tip, there are cream-colored ear pinna

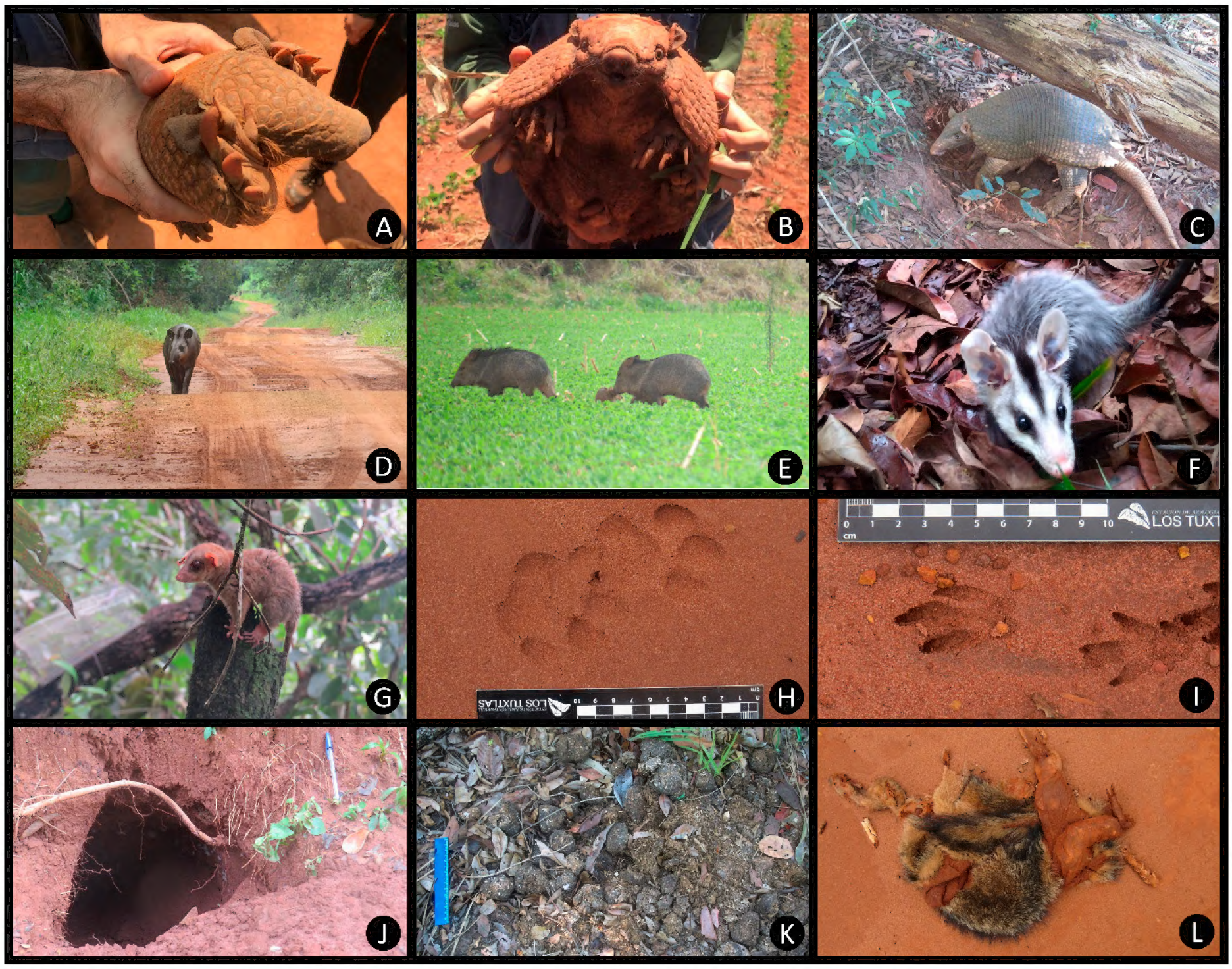

Figure 7. Mammalian species recorded by others method type in the Serra da Fortaleza Wildlife Refuge, southern Goiás, central Brazil. **A–E.** Direct observation: (**A**) *Cabassous squamicaudis*, (**B**) *Euphractus sexcinctus*, (**C**) *Priodontes maximus*, (**D**) *Tapirus terrestris*, (**E**) *Dicotyles tajacu*. **F–G.** Live-trapped: (**F**) *Didelphis albiventris*, (**G**) *Caluromys philander*. **H, I.** Tracks: (**H**) *Puma concolor*, (**I**) *Dasyprocta azarae*. **J.** Burrow, *Priodontes maximus*. **K.** Feces, *Tapirus terrestris*. **L.** Roadkill, *Cerdocyon thous*.

near the auditory canal, and the tail is visibly hairy. *Marmosa murina* can be distinguished from *M. limae* by its smooth body fur, which extends up to 1 cm on the proximal portion of the tail (to at least 2 cm in *M. limae*), and a uniformly pigmented tail (generally depigmented on the distal portion in *M. limae*) (Voss et al. 2020; Antunes et al. 2021a).

***Marmosa* (*Micoureus*) *limae* Thomas, 1920**

New records. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18.2451, –050.6774; 785 m; 17.XI.2022; HWPC skin and skull.; seasonal semi-deciduous forest, wire-cage live trap; 1♂, CMUEG-187.

Identification. The pelage is wooly, dorsally grayish brown tinged with cream or yellow, and the underbelly is yellowish or cream. A broad band of gray-based lateral hairs may coalesce on the chest or abdomen. See *M. murina* for the morphological differences between the two *Murina* species in this study (Gardner 2008; Voss et al. 2020; Antunes et al. 2021a).

***Monodelphis* (*Mygalodelphis*) *kunsi* Pine, 1975**

Materials examined. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18.2434, –050.6883; 785 m; 31.V.2022; ACBD skin and skull.; seasonal semi-deciduous forest, wire-cage live trap; 1♀, CMUEG-118.

Identification. The fur is short, generally warm-brown dorsally and with whitish areas ventrally. The tail is bicolored, darker dorsally and buff ventrally; it is covered by fine hairs, except the tip, which may serve a tactile function. We adopted *Monodelphis* (*Mygalodelphys*) *kunsi* in this study according Pavan and Voss (2016).

Order Cingulata Illiger, 1811
Family Chlamyphoridae Bonaparte, 1850
Subfamily Tolypeutinae Gray, 1865

***Cabassous squamicaudis* (Lund, 1845)**
Figure 7A

Materials examined. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18.2451, –050.6774; 785 m; 27.VIII.2021; WH obs.; seasonal semi-deciduous forest, burrow, and direct observation; CMUEG-198.

Identification. There is no dermal shield coverage on its tail. Its carapace is dark gray, divided by 10–13 mobile bands that are not very well delimited. The body

is 29.0–40.5 cm long, and the tail length averages 12 cm long. *Cabassous squamicaudis* can be distinguished from *C. tatouay* in having more than 50 dermal scutes on its cephalic shield (Emmons and Feer 1997; Feijó and Anacleto 2021).

***Priodontes maximus* (Kerr, 1792)**
Figure 7C, J

Materials examined. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18.2451, –050.6774; 785 m; 05. X.2020; WH obs.; seasonal semi-deciduous forest, direct observation, burrow, and camera trap; CMUEG-107.

Identification. This is the largest species in the order Cingulata, reaching 150 cm in body length and weighing up to 50 kg. The carapace has 11–13 moveable bands. The body is dark brown, but with a pale head, tail, and stripe around the edges of the body (Emmons and Feer 1997; Hannibal et al. 2015a).

Subfamily Euphractinae Pocock, 1924

***Euphractus sexcinctus* (Linnaeus, 1758)**
Figure 7B

Materials examined. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18.2451, –050.6774; 785 m; 20.XI.2022; CA obs.; seasonal semi-deciduous forest, camera trap; CMUEG-199.

Identification. The armor is brown-yellowish, the head is conical, and body has 6–8 flexible bands with long, whitish hairs (Emmons and Feer 1997; Hannibal et al. 2015a).

Family Dasypodidae Gray, 1821
Subfamily Dasypodinae Gray, 1821

***Dasypus novemcinctus* (Linnaeus, 1758)**
Figure 6I

Materials examined. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18.2451, –050.6774; 785 m; 02. XI.2021; CA obs.; seasonal semi-deciduous forest, direct observation, roadkill and camera trap; CMUEG-190.

Identification. The weight is 3.2–4.1 kg. Its armor is dark brown and has 8–10, but usually nine, flexible bands in the mid-section (Emmons and Feer 1997; Feijó et al. 2019).

Order Pilosa Flower, 1883
Family Myrmecophagidae Gray, 1825

***Myrmecophaga tridactyla* (Linnaeus, 1758)**
Figure 6G

Materials examined. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18.2451, –050.6774; 785 m; 08. XII.2022; CA obs.; seasonal semi-deciduous forest, direct observation, tracks, and camera trap; CMUEG-191.

Identification. The color is brownish gray, with a wide, black stripe outlined in white from the upper front legs to the spine. The body is covered with long, thick, coarse hairs. There is a long, distinctive snout and a bushy tail (Emmons and Feer 1997; Hannibal et al. 2015a).

***Tamandua tetradactyla* (Linnaeus, 1758)**
Figure 6H

Materials examined. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18.2451, –050.6774; 785 m; 10. VIII.2022; CA obs.; seasonal semi-deciduous forest, direct observation, and camera trap; CMUEG-192.

Identification. This species exhibits short pale, yellow hairs with two black stripes that extend to the shoulders. The head is elongate due to its long snout (Emmons and Feer 1997; Hannibal et al. 2015a).

Order Primates Linnaeus, 1758
Family Cebidae Gray, 1830
Subfamily Callitrichinae Thomas, 1903

Callithrix penicillata (É. Geoffroy, 1812)

Materials examined. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18.2451, –050.6774; 785 m; 13. XI.2022; CA obs.; seasonal semi-deciduous forest, direct observation.

Identification. This is a small-bodied marmoset (250–300 g), having fur a mixture of gray, black and red. Black tufts of hair around the ears and a white spot on the face are charactertistic (Emmons and Feer 1997; Hannibal et al. 2015a).

***Sapajus libidinosus* (Spix, 1823)**
Figure 6J

Materials examined. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18.2451, –050.6774; 785 m; 18. XI.2022; CA obs.; seasonal semi-deciduous forest, direct observation, tracks, and camera trap; CMUEG-200.

Identification. The coat is short and thick, varies in color from light brown to mustard yellow but darker on the back and with reddish-brown lower parts. The sides and the front of its face are dirty white (Alfaro et al. 2012).

Order Lagomorpha Brandt, 1855
Family Leporidae Fischer, 1817

***Sylvilagus minensis* (Thomas, 1901)**

Materials examined. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18.2451, –050.6774; 785 m; 05. V.2022; CA obs.; seasonal semi-deciduous forest, camera trap; CMUEG-193.

Identification. The eyes are dark, the ear are close, and there is dense, short fur. The dorsal fur is yellowish-brown, and the abdomen is lighter (Emmons and Feer 1997; Hannibal et al. 2015a).

Order Rodentia Bowdich, 1821
Family Caviidae Fischer, 1817

***Hydrochoerus hydrochaeris* (Linnaeus, 1766)**

Materials examined. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18.2451, –050.6774; 785 m; 01.

V.2020; WH obs.; seasonal semi-deciduous forest, tracks.

Identification. The coat is usually reddish-brown, but lighter on the abdomen. The ears and eyes are small and near the top of the head (Emmons and Feer 1997; Hannibal et al. 2015a).

Family Cricetidae Fischer, 1817
Subfamily Sigmodontinae Wagner, 1843
Tribe Oryzomyini Vorontsov, 1959

Cerradomys scotti (Langguth & Bonvicino 2002)

New records. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18.2451, –050.6774; 785 m; 27.VIII.2020; ACBD skin and skull.; seasonal semi-deciduous forest, wire-cage live trap; 1♀, 1♂, CMUEG-060, CMUEG-061.

Identification. The back varies in color from grayish to yellowish brown; the belly is grayish. The tail has bicolor, dense hair, and there is no brush at the apex. *Cerradomys scotti* differs from other *Cerradomys* species in presenting a gray-whitish ventral coloration with or without yellow tones (grayish-yellowish belly in *C. maracajuensis*) and a tail intensely covered with fur and strongly bicolored (moderately covered with fur and slightly bicolored in *C. maracajuensis*). *Cerradomys scotti* differs from *C. akroai* in dorsal body color, which is darker in the *C. akroai* (Bonvicino et al. 2008; 2014; Patton et al. 2015; Antunes et al. 2021b).

Hylaeamys megacephalus (G. Fischer, 1814)

New records. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18.2451, –050.6774; 785 m; 11.I.2020, 23.V.2021; ACBD skin and skull.; seasonal semi-deciduous forest, wire-cage live trap; 2♀, 1♂, CMUEG-059, CMUEG-116, CMUEG-119.

Identification. The dorsal fur is short, dense, and overall ochraceous, yellowish, or orangish and weakly to moderately ticked with dark brown. The ventral fur is shorter and predominantly gray. The tail uniform in color (Bonvicino et al. 2008; Patton et al. 2015; Antunes et al. 2021b).

Oecomys catherinae Thomas, 1909

Materials examined. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18.2526, –050.6566; 785 m; 18.VI.2022; ACBD skin and skull.; seasonal semi-deciduous forest, wire-cage live trap; ♂, CMUEG-189.

Identification. *Oecomys catherinae* is a larger size *Oecomys* species, with ventral pelage coloration characterized by grey-based hairs. Our specimens contrast with *O. cleberi*, which have uniformly colored hairs in the ventral pelage (pure white or yellowish on the venter) and are smaller. The pelage of *O. catherinae* is long, dense, and relatively lax, with a vague distinction between the dorsal (tawny brown) and ventral (grey-based and white-tipped hairs) coloration (Bonvicino et al. 2008; Patton et al. 2015; Suárez-Villota et al. 2018).

Oecomys cleberi Locks, 1981

Materials examined. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18,2468, –050,6819; 785 m; 11.XI.2020, 23.V.2021, 27.V.2021, 9.XI.2021, 15.XI.2021, 21.XI.2021; ACBD skin and skull.; seasonal semi-deciduous forest, wire-cage live trap; 3♀, 3♂, CMUEG-114, CMUEG-122, CMUEG-124, CMUEG-135, CMUEG-216, CMUEG-217.

Identification. The underparts are pure white to pale cream and sharply contrast with the orange-brown upper parts. The tail is relatively short tail and with a modest terminal tuft. Compare with this species with *O. catherinae* (Bonvicino et al. 2008; Suárez-Villota et al. 2018).

Oligoryzomys mattogrossae (J. A. Allen, 1916)

Materials examined. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18,26975, –050,6429; 785 m; 10.XI.2020; ACBD skin and skull.; seasonal semi-deciduous forest, wire-cage live trap; 2♂, CMUEG-062, CMUEG-063.

Identification. The dorsal pelage is grayish-yellowish with reddish tones, especially on the rump; the base of the hairs is light ochre. On the sides, the pelage is lighter than on the back, and there is no well-defined border with the yellowish undercoat. *Oligoryzomys mattogrossae* differ from other *Oligoryzomys* species in Goiás state by the following: *O. moojeni* has the ventral sides of the limbs entirely cream-colored; *O. rupestris* has whitish ventral coloration; *O. nigripes* is larger than *O. mattogrossae* and dark-brown to dark-yellowish dorsal pelage with a well-defined limits with the whitish ventral coloration; and *O. stramineus* is also larger and has paler dorsal pelage and well-defined limits between lateral and whitish ventral pelage (Weksler and Bonvicino 2005; Bonvicino et al. 2008; Patton et al. 2015; Antunes et al. 2021b).

Tribe Phyllotini Vorontsov, 1959

Calomys expulsus (Lund, 1840)

Materials examined. BRAZIL - GOIÁS • Serra da Fortaleza Wildlife Refuge; –18.2762, –050.6436, 785 m; 15.XI.2022, 18.XI.2022, ACBD skin and skull.; seasonal semi-deciduous forest, wire-cage live trap; 1♀, 2♂, CMUEG-212, CMUEG-218, CMUEG-220.

Identification. The tail shorter than the head and body, averaging 74% of combined length of the head and body. The dorsal pelage yellowish to olive brown, and the venter is covered with white-tipped but gray-based hairs. There are tufts of white hair behind the ears. The foot is dorsally covered with short, white hairs. *Calomys expulsus* differ from *C. tener* in their morphometric analysis, where *C. expulsus* specimens are significantly larger: head–body length 99.7 mm ± 14.0 (vs. 77.5 mm ± 7.2 in *C. tener*), tail length 72.1 mm ± 10.0 (vs. 60.6 mm ± 13.6), feet length including claws 20.2 mm ± 1.1 (vs. 16.6 mm ± 1.1), ear length 17.0 mm ± 1.7 (vs. 14.2 mm ±

1.2), and weight 28.2 g ± 5.9 (vs. 14.5 ± 2.4). (Bonvicino and Almeida 2000; Bonvicino et al. 2008).

***Calomys tener* (Winge, 1887)**

Materials examined. BRAZIL - GOIÁS • Serra da Fortaleza Wildlife Refuge; –18,2724, –050,6885, 785 m; 15.II.2021, 23.V.2021, ACBD skin and skull.; seasonal semi-deciduous forest, wire-cage live trap; 3♂, CMUEG-110, CMUEG-120, CMUEG-121.

Identification. The upper parts of the body are yellowish to dark brown, and there is reddish hue in some specimens. The hairs are gray at their base. The venter is pale to dark gray, and the ventral region grayish to whitish with the base of hairs gray. Compare this species and *C. expulsus* (Bonvicino and Almeida 2000; Bonvicino et al. 2008; Patton et al. 2015; Antunes et al. 2021b).

Tribe Thomasomyini Steadman and Ray, 1982

***Rhipidomys macrurus* (Gervais, 1855)**

Materials examined. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18.2526, –050.6566; 785 m; 17.XI.2022; ACBD skin and skull.; seasonal semi-deciduous forest, wire-cage live trap; 1♂, CMUEG-156.

Identification. The dorsal pelage is reddish gray-brown, and the underparts are white or pale cream, frequently with the hairs having gray bases. The tail is slightly longer than the combined length of the head and body. The ears are large and brown. The hind feet has a dark dorsal patch which is either sharply or diffusely edged. According to Campos et al (2022), *R. macrurus* occurs in Brazil in the Distrito Federal and Minas Gerais, Goiás, and Mato Grosso do Sul (as well as in Paraguay), while *R. mastacalis* occurs only in eastern Brazil, from Paraíba to Rio de Janeiro state. There are some craniometric differences between *R. macrurus* and *R. mastacalis*: nasolacrimal capsule less inflated in *R. macrurus* versus inflated in *R. mastacalis*, zygomatic notch shallow versus deeper, and interorbital breath smaller versus larger (Bonvicino et al. 2008; Patton et al. 2015; Antunes et al. 2021b).

Family Cuniculidae G.S. Miller & Gidley, 1918

***Cuniculus paca* (Linnaeus, 1766)**

Figure 6F

Materials examined. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18.2451, –050.6774; 785 m; 11.V.2021; CA obs.; seasonal semi-deciduous forest, tracks, and camera trap; CMUEG-201.

Identification. The dorsal and head fur is reddish to dark brown; the sides of the body are lighter and have a rounded, whitish spots in longitudinal lines. The body is robust, the large head, the ears short, and the eyes big eyes. The body length range is 650–739 mm, and the body mass range is 9.2–9.5 kg (Emmons and Feer 1997; Bonvicino et al. 2008; Hannibal et al. 2015a).

Family Dasyproctidae Bonaparte, 1838

***Dasyprocta azarae* (Lichtenstein, 1823)**

Figure 7I

Materials examined. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18.2451, –050.6774; 785 m; 23.V.2021; CA obs.; seasonal semi-deciduous forest, direct observation, tracks and camera trap; CMUEG-194.

Identification. The top of the head and cheeks have brown flecks. The dorsal fur down to the waist is brown and sprinkled with small orange spots. *Dasyprocta azarae* differs from *D. leporina* in having the posterior dorsal area olive-gray and sprinkled with small, cream-colored spots; *D. leporina* is generally brown alternating with orange (Hannibal et al. 2015a; Feijó and Langguth 2018).

Family Erethizontidae Bonaparte, 1845

***Coendou longicaudatus boliviensis* (Brandt, 1835)**

Materials examined. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18.2451, –050.6774; 785 m; 26.VIII.2021; CA obs.; seasonal semi-deciduous forest, camera trap.

Identification. The coat consists of long (>10 cm), curved spines, with a general color pattern mixed appearing as whitish-brown. The spines are tricolored, with a whitish apical band. The belly is yellowish white to brownish white. The ears are short, and there are large, well-developed eyes. The tail is prehensile, with tricolored spines on its proximal half and the terminal portion bare. There is no similar species in Goiás. It is the largest Neotropical porcupine and has an average weight of 4.1 kg (range 2.3–5.6 kg) (Antunes et al. 2021b; Menezes et al. 2021).

Order Carnivora Bowdich, 1821
Family Canidae Fischer, 1817

***Cerdocyon thous* (Linnaeus, 1766)**

Figure 7L

Materials examined. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18.2451, –050.6774; 785 m; 18.V.2021; CA obs.; seasonal semi-deciduous forest, camera trap, tracks and roadkill; CMUEG-202.

Identification. The fur varies from gray to brown, and there is a black stripe from the nape to the tip of the tail. The chest and abdomen are light-colored, and the legs and tail are black (Emmons and Feer 1997; Hannibal et al. 2015a).

***Chrysocyon brachyurus* (Illiger, 1815)**

Figure 6A

Materials examined. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18.2451, –050.6774; 785 m; 17.VIII.2022; CA obs.; seasonal semi-deciduous forest, camera trap and tracks; CMUEG-203.

Identification. Most of the body is covered by

reddish-brown fur, but the tip of the tail, throat, and inner ears are white. The legs, snout, and mane are black. The body length range is 950–1150 mm, and the body mass range is 20–30 kg (Emmons and Feer 1997; Hannibal et al. 2015a).

Family Felidae Fischer, 1817
Subfamily Felinae Waldheim, 1817

***Puma concolor* (Linnaeus, 1771)**
Figure 7H

Materials examined. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18.2451, –050.6774; 785 m; 26.V.2021; WH obs.; seasonal semi-deciduous forest, direct observation, tracks and camera trap; CMUEG-207.

Identification. The coat is unspotted and varies from grayish to reddish brown (Emmons and Feer 1997; Hannibal et al. 2015a).

***Leopardus pardalis* (Linnaeus, 1758)**
Figure 6B

Materials examined. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18.2451, –050.6774; 785 m; 26.VIII.2021; CA obs.; seasonal semi-deciduous forest, camera trap; CMUEG-204.

Identification. The fur is usually short, smooth, and slightly stiff, rarely soft and woolly. The coat is pale grayish yellow with rosettes which form a striped pattern on the sides. The paws are light brown (Emmons and Feer 1997; Hannibal et al. 2015a).

Family Mustelidae Fischer, 1817
Subfamily Guloninae Gray, 1825

***Eira barbara* (Linnaeus, 1758)**
Figure 6C

Materials examined. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18.2451, –050.6774; 785 m; 16.VIII.2022; CA obs.; seasonal semi-deciduous forest, camera trap; CMUEG-205.

Identification. The body is usually melanistic and mostly black or gray. This species differs from *Lontra longicaudis* in being smaller and having a cream-colored or orange-spotted neck. The body is 560–860 mm long, and the body mass is 3.7–11.1 kg (Emmons and Feer 1997; Hannibal et al. 2015a).

Family Procyonidae Gray, 1825

***Nasua nasua* (Linnaeus, 1766)**
Figure 6D

Materials examined. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18.2451, –050.6774; 785 m; 19.V.2021; CA obs.; seasonal semi-deciduous forest, camera trap and direct observation; CMUEG-195.

Identification. The head is triangular and with a trumpet-shaped snout. The dorsal pelage is light yellowish to dark gray, and the face is dark, bordered with white. The tail is long and with dark and light colors (Emmons and Feer 1997; Hannibal et al. 2015a).

***Procyon cancrivorus* (Cuvier, 1798)**
Figure 6E

Materials examined. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18.2451, –050.6774; 785 m; 18.XI.2022; CA obs.; seasonal semi-deciduous forest, camera trap; CMUEG-196.

Identification. There is a black mask running from the eyes to the base of the jaw, and above this mask is a pair of white spots. The coat is dense, short and varies from dark brown to gray, and the tail has several dark rings (Emmons and Feer 1997; Hannibal et al. 2015a).

Order Perissodactyla Owen, 1848
Family Tapiridae Gray, 1821

***Tapirus terrestris* (Linnaeus, 1758)**
Figure 7E, K

Materials examined. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18.2451, –050.6774; 785 m; 07.I.2020; WH obs.; seasonal semi-deciduous forest, feces, camera trap, direct observation, and tracks; CMUEG-106.

Identification. This is the largest mammal observed in this study. The body is grayish and robust body, and the head has a small, movable trunk. There is a prominent sagittal crest (Emmons and Feer 1997; Hannibal et al. 2015a).

Order Cetartiodactyla Montgelard, Catzeflis & Douzery, 1997
Family Cervidae Goldfuss, 1820
Subfamily Capreolinae Brookes, 1828

***Mazama americana* (Erxleben, 1777)**
Figure 6K

Materials examined. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18.2451, –050.6774; 785 m; 13.XI.2022; CA obs.; seasonal semi-deciduous forest, camera trap; CMUEG-208.

Identification. The body is mostly reddish-brown but varies from light to very dark. The neck is brown and contrasts with the color of the trunk, and there are white blotches at the bases of the ears (Emmons and Feer 1997; Hannibal et al. 2015a).

***Subulo gouazoubira* (Fischer, 1814)**

Materials examined. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18.2451, –050.6774; 785 m; 17.II.2021; CA obs.; seasonal semi-deciduous forest, camera trap; CMUEG-197.

Identification. The coat is nearly uniform in color and varies from grayish brown to reddish brown, although the hips and back of tail are orange-brown and the abdomen is lighter, with shades of beige and gray. The head is relatively large (Emmons and Feer 1997, Hannibal et al. 2015a).

Family Tayassuidae Palmer, 1897

***Dicotyles tajacu* (Linnaeus, 1758)**
Figure 7F

Materials examined. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18.2451, –050.6774; 785 m; 11.XI.2020; WH obs.; seasonal semi-deciduous forest, direct observation, tracks and camera trap; CMUEG-108.

Identification. The coat is black or brown and with a white color around the neck (Emmons and Feer 1997; Hannibal et al. 2015a).

***Tayassu pecari* (Link, 1795)**
Figure 6L

New records. BRAZIL – GOIÁS • Serra da Fortaleza Wildlife Refuge; –18.2451, –050.6774; 785 m; 17.XI.2022; CA obs..; seasonal semi-deciduous forest, camera trap; CMUEG-206.

Identification. The upperparts are uniformly black or sometimes brownish. The hair is very long and coarse, and individual hairs have few or no pale bands. The chin and area near the corner of mouth and lower are cheek white (Emmons and Feer 1997; Hannibal et al. 2015a).

Discussion

The Serra da Fortaleza Wildlife Refuge and its surroundings harbor 30.7% of the non-volant mammal fauna of Goiás state (Hannibal et al. 2021), with orders Rodentia, Carnivora, and Didelphimorphia being the most species-rich. The community comprises many infrequent species and a few common ones. Despite this, the community was satisfactorily sampled, representing approximately 91% of the number of species estimated for the fragmented landscape. The good representation of the local community in our study is due to the use of several sampling and capture methods employed in this study (Voss and Emmons 1996).

The data on the 39 species of non-volant mammals recorded here have great importance for the understanding of local biodiversity and help fill the knowledge gap in protected areas (Oliveira et al. 2017). The south-central region of Goiás, which is composed of the Cerrado biome, is the most deforested region of the state and fewer protected areas than in the north of the state (Françoso et al. 2015). Studies on non-volant mammals (small, medium-sized, and large) are scarce in southeastern Goiás (Gomes et al. 2015; Hannibal et al. 2015b). Emas National Park, in the extreme southwest of Goiás state and having an area of approximately 133,000 ha, was the sole protected area for which the mammalian fauna was well known (Rodrigues et al. 2002; Carmignotto et al. 2014).

Rodentia, Carnivora, and Didelphimorphia are three of the most representative mammalian orders in the Brazilian Cerrado (Carmignotto et al. 2012, 2022; Paglia et al. 2012) and in Goiás (Hannibal et al. 2021). Specifically, the community composition and structure are represented by few common but abundant species and many rare species, a pattern that is the rule in community ecology (Magurran 2004). Tapirs, peccaries, agoutis, and opossums (the frequent species) are important for the functioning of the ecosystem and contribute to an ecologically balanced habitat (Balvanera et al. 2006). These species' ecological role, as frugivores or herbivores, contribute to the maintenance and regeneration of vegetation by seed dispersal (Cáceres 2002; Lessa and Costa 2008; Galetti et al. 2015; Hannibal et al. 2019), and they are prey of meso- and top-chain carnivores (Garla et al. 2001; Bueno and Motta-Junior 2006; Barbosa et al. 2021). Additionally, rare species contribute to the integrity of ecological processes and the maintenance of ecosystems, and their loss leads to significant reductions in functional richness at local and regional scales (Leitão et al. 2016). Furthermore, knowledge of rare species enhance our understanding of local diversity. For example, the marsupial *Marmosa limae*, the small rodents *Cerradomys scotti* and *Hylaeamys megacephalus*, and the White-lipped Peccary had not previously been recorded in the fragmented landscape of the Quirinópolis microregion (Hannibal et al. 2015b; Oliveira and Hannibal 2017). Our discovery of these species in the study area emphasizes the importance of this protected area for maintaining biodiversity in southern Goiás.

The implementation of several sampling methods in our study was crucial in collecting data for your study. This was confirmed by the accumulation curve and the richness-estimator analyses. Additionally, our use of camera traps and live traps for small-mammals enabled us to examine species diversity gradients using Hill numbers, which provide insights into the impact of both rare and abundant species on the community (Jost 2006; Roswell et al. 2021). Consequently, we were able to plot species richness, Shannon diversity, and Simpson dominance on a unified scale, confirming that the community structure is influenced by species rarity.

We found that the live traps and pitfall traps were essential in sampling marsupials and small rodents; only the marsupial *D. albiventris* was frequently recorded in camera traps. Pitfall traps have been widely employed in small mammal studies in the Neotropical region (Bovendorp et al. 2017). In southern Goiás, there is no distinction between wire cage and Sherman trap types in the capture of small mammals, except that *D. albiventris* is more frequently captured in wire cage traps, and *Monodelphis kunsi* is exclusively captured in pitfall traps (Figueiredo et al. 2021). We recorded all mammalian orders in camera traps, while direct observations and tracks also contributed data on medium-sized and large mammals. The success of sampling by camera traps has also been reported by Srbek-Araujo and Chiarello (2005), and combining camera traps and active searches to inventory medium-sized and large mammals is essential for successful sampling (Laurindo et al. 2019). It is important to note that owl pellets

are useful in surveying small mammals, although we did not collect and study them; owl pellets have proven to be highly effective in accessing species that are sometimes not sampled by conventional methods (Cherem et al. 2018). Thus, there is no single method that is optimal in all situations, and arboreal species, for example, are hardly recorded in camera traps (Estrela et al. 2015; Santos and Mendes-Oliveira 2012), so a combination of methods are needed (Kasper et al. 2007).

We conclude that the Serra da Fortaleza Wildlife Refuge—the largest forest remnant in the Quirinópolis micro-region—and its surroundings harbor a rich fauna of non-volant mammals. Future studies should investigate the habitat- and landscape-scale parameters that influence the taxonomic, functional, and phylogenetic diversity of the mammal community in this fragmented landscape. Studies on the conservation and ethnozoology of the region are needed to better understand the threats to the wild mammal fauna from hunting, retaliation from predator attacks on livestock, and the presence of domestic animals and invasive species.

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